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THE CLASSIFICATION OF THE SCIENCES.

OF the numerous schemes of classification of the sciences that have been formulated in the history of philosophical speculation, three only will be briefly considered in the course of this article, and afterwards an attempt will be made to state the principles upon which a true classification should be based. The three systems to be thus considered will be those that have been developed latest in the history of thought. By this means the labors of previous thinkers will be utilized, and, at the same time, the advantage that accrues from the analysis of distinct and original types of classification will be more or less adequately realized.

The first, historically, of these three types of classification was that of Auguste Comte.[1] The basis upon which Comte's classificatory system was established was the fundamental distinction between the abstract and the concrete. The sciences, according to Comte, develop both logically and historically from the abstract and the simple to the concrete and the complex. Each successive stage in this development is determined by the preceding stage: every science receives the laws which render its existence possible from the sciences which have preceded it in the series. The six main sciences which have thus been formed in the course of the evolution of thought are mathematics, astronomy, physics, chemistry, biology and sociology. The hierarchical character of Comte's scheme of classification is seen in the fact that mathematical laws are indispensable to the exact ascertainment of astronomical phenomena; that the law of gravitation which holds universally throughout the stellar world is employed in the determination of such a physical process as the fall of a body to the earth; and that the exact determination of the nature of biological processes implies a prior knowledge of physical and chemical laws. That the sciences in this scheme treat of phenomena of ascending degrees of complexity is evident from the consideration that each of the sciences includes the facts and methods of those sciences that are earlier in the series, as well as introduces new facts and methods of its own. That these sciences are in the order of decreasing generality or abstractness is obvious when we consider that mathematics is applicable to all spatial phenomena; that astronomy deals with celestial, while physics is concerned with the narrower field of terrestrial bodies; and that sociology is simply that department of biology which treats of highly developed living beings in their manifold interrelations. This relation of abstract to concrete holds not only of the sciences considered in their serial order, but characterizes their content when taken separately. Thus there is an abstract mathematics, the calculus, and a concrete mathematics, which is composed of general geometry and of rational mechanics. There is an abstract or mathematical astronomy, and a concrete or descriptive astronomy. There is a physics that deals with the principles that underlie the composition and resolution of forces, a physics that is concerned with the application of these principles to the concrete movements of masses and molecules, as well as a physics that describes the varied properties of matter. All the sciences, in the same way as those that have just been mentioned, may be regarded either from the point of view of the universal principles that underly them, or from that of the particular facts that form the subject-matter of investigation.

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[1] Positive Philosophie, Book I., Ch. II.

Although Comte's classification marked a distinct advance over that of any of his predecessors, it has yet encountered severe and merited criticism at the hands of thinkers who have since been concerned with the same line of inquiry. Of these criticisms, the most acute and far-reaching is that of Herbert Spencer.[1] In the first place, Spencer shows that Comte's use of the terms abstract and concrete is quite unwarrantable in the connection in which he employs them. An abstract science is one subject-matter of which consists of conceptions that have been dissociated from the concrete objects of sense-perception, and considered solely upon their own account. In this sense of the term, astronomy, for instance, is not in any way more abstract

[1] Essays: Genesis of Science and Classification of the Sciences.

than biology. Both are concerned with objects having groups of qualities that are accessible to observation and hence are equally concrete. What does hold of the two instances just mentioned is that the former is more *general* than the latter, that is, that its objects are more widely distributed in space and time. But even if generality in place of abstractness is regarded as the basis of Comte's scheme of classification, the order of decreasing generality, that he presents, does not conform to the facts of the case. Physics has not a wider 'extension' than chemistry. Neither the objects with which physics nor those with which chemistry is concerned are less widely distributed than are astronomical phenomena. Rather the reverse is the case, since the former sciences treat of all objects that have a material constitution. Even if the unwarranted view be taken that Comte's decreasing generality is based not upon *possible* but upon *actual* objects of perception, it would still be untrue that physics is, at the present time, less general than astronomy, as spectrum analysis has rendered the two fields virtually co-incident.

Another criticism, which Mr. Spencer makes against Comte's scheme of classification, is that the asserted dependence of the sciences, that come later in the series, upon those that come earlier, has neither historical nor logical justification. Abstract was not developed earlier than concrete mathematics. Algebra, which is based upon a generalization of numerical quantities, and hence is more abstract than arithmetic, became an exact science after the latter science had reached a highly organized form. Astronomy advanced to the position of an exact science *pari passu* with an advance in the knowledge of physical facts and laws. The law of gravitation, for example, was not first discovered as an astronomical fact and afterwards applied to the relations obtaining between the earth and the bodies on or near its surface. Its discovery, on the other hand, was rendered possible by inductions from observed terrestrial movements, and by the deductive employment of previously discovered physical laws, such as that of the acceleration of falling bodies. In each of the above mentioned instances, the historical development of the sciences in question took place in the reverse direction from that indicated in Comte's celebrated scheme. Nor is the logical development of the sciences what Comte has asserted it to be. The natural order of mental development is not from the abstractly simple to the concretely complex, but is rather from the vague and indefinite, in which parts are only imperfectly distinguished, to the exact and definite in which the parts, while more clearly differentiated, become at the same time more closely connected with one another. It is in following out this logical law of evolution that the sciences have advanced from a comparatively chaotic condition to a position of high and increasing organization. The real sciences have invariably developed from a narrow to a wide observation of facts, and from narrow and inexact to wide and exact generalizations. Comte is wrong then in claiming that the concrete stages of a given science are dependent upon its abstract stages, since every stage, through which a science in the course of its evolution passes, is both more abstract and more concrete, that is, more highly differentiated, than that out of which it arose. The dependence in this case is that of a state of higher organization upon a state of lower organization. In the same way the separate sciences, taken as wholes, are not merely dependent upon single sciences more abstract than themselves, but are dependent, to a greater or less extent, upon the whole body of scientific knowledge which has been previously elaborated.

The third and last fundamental objection that may be raised to Comte's classification, that, namely, to its *linear* character, has been more especially emphasized by Professor Wundt.[1] The sciences, as this author points out, are not so empty of significance as to bear to one another the relation merely of superordination and subordination. Physics and chemistry, for example, could never reach the position of exact deductive sciences without the aid of mathematical laws ; but mathematics, in turn, receives an impulse to its further development by its application to the concrete subject-matter of these sciences. A certain mathematical preparation is required for the study of experimental physics, yet this discipline is also indispensable to the transition to the higher mathematics. In the psycho-physical individual, physical, chemical, biological and psychical processes interact in all degrees of closeness and complexity, and the sciences that treat of those processes have a corresponding closeness and complexity of interrelation. Nowhere do we find evidence in nature of dependence pure and simple, but always of *inter*-dependence; and consequently, any arrangement of the sciences upon the ground of pure logical superiority and inferiority is quite without justification.

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[1] Eintheilung der Wissenschaften, Phil. Studien, Vol. 5. P. 1–55.

Mr. Spencer has sought to rectify Comte's errors by constructing a scheme of classification upon a new foundation. Instead of arranging the sciences in a constantly descending order of abstractness and simplicity, Mr. Spencer makes three sharp divisions of the whole field of knowledge and under each of these divisions brings a whole group of sciences. The three divisions of his system are the abstract, the abstract-concrete and the concrete. The abstract sciences are those which deal with the abstract relations of co-existence and sequence under which phenomena are presented to us, rather than with phenomena themselves. Logic is the science that treats of these relations in their qualitative character, and mathematics the science that deals with the relations in their quantitative aspect. The concrete sciences, again, are those that deal with the single objects of sense-perception, regarded not in their elements but as totalities. Between these two groups stand, as the name implies, the abstract-concrete sciences. These sciences seek to determine the laws of the actions of things, not in the context in which these things occur, but under ideally perfect conditions. They are concrete inasmuch as they deal with particular objects that exist in space and time. They are abstract to the extent that these objects are regarded as dissociated from all interfering conditions, and the laws of their movement in space determined upon their own account. These groups of sciences again, have within them a common principle of division, that, namely, of regarding the sciences from a general and from a special point of view. Thus the abstract-concrete sciences are considered from the point of view of the universal laws of force, as deduced from the persistence of force (the theorems of resolution and composition) and from that of the laws of force as manifested in masses and molecules. The concrete sciences are viewed both from the standpoint of the universal laws of the continuous redistribution of matter and motion, and from the standpoint of this redistribution as actually going on. Thus Spencer has carried out his logical principle of the division of the sciences into abstract and concrete, both in his classification as a whole, and in the division that he makes within each of the main groups of sciences.

While Spencer has presented a much more elaborate scheme of classification than that of Comte, and has in many respects improved upon the latter's system, he has yet retained several of the faults of his predecessor, as well as added new defects of his own. In common with Comte, he regards metaphysics as having no peculiar content or method of its own, but as being simply the highest and most abstract generalization of material phenomena. As this highest generalization, with Spencer, refers to a reality that is wholly unknowable, he is only consistent with his own philosophy when he fails to introduce into his system of classification any of the metaphysical disciplines. He thus fails to recognize that metaphysics has a province distinct from that of the special sciences—an enquiry, namely, into the ultimate nature of the presuppositions which science without question accepts. For a like reason, namely, that his philosophy is essentially materialistic, Spencer follows Comte in making psychology one of the subdivisions of biology. Whatever justification there may be for this position from the standpoint of organic evolution, it is certain that, from a logical point of view, psychical processes are as legitimately the object of scientific enquiry as are any of the processes of the material world. The one set of processes is as real as the other, and a classification that ignores either lays itself open to the charge of neglecting one-half of the field of possible scientific exploration.

Spencer's scheme of classification has been criticised by Wundt, in the article which has been referred to above, on the ground that the distinction which the former author makes between the concrete and the abstract-concrete, or, in other words, between sciences that deal with totalities, and sciences that deal with isolated forces, has not sufficient basis in reality. Thus the sciences which Spencer places under the head of the concrete, such as astronomy and physiology, may be regarded, just as well as chemistry and physics, as sciences that deal with elements in abstraction from their immediate context. So, also, the subject matter of physics and chemistry has just as much a concrete side, and is as much open to observation as is that of biology and psychology. In the same way, Wundt claims that Spencer's distinction between the abstract and the abstract-concrete sciences has not sufficient justification in the nature of the subject-matter with which these sciences deal. The abstractions which lie at the base of this division differ not merely in degree, but also in kind. Mathematics does not treat merely of relations which have been abstracted from the concrete relations of things, but it constructs for itself conceptual objects that are fundamentally different from the conceptions that lie at the foundation of the physical sciences. Of these new constructions it may be said, that the first impulse to their formation, but not their material, is given in concrete objects and their relations. The true distinction between the two groups of sciences is that between those that treat of real and those that treat of formal objects and relations. The former sciences are concerned with the properties of concrete phenomena; the latter with the order or arrangement of these phenomena in space and time. This latter point of view is not the result of abstraction from the objects given in perception, but is an original attitude of the mind towards the real world. It follows, then, that the mathematical sciences must be placed in a category quite distinct and separate from the sciences that treat of the sensible properties of things.

Wundt has himself proposed a method of classification which obviates many of the objections to which Spencer's scheme is open. The sciences he divides into the formal or mathematical, the real, and the philosophical. The formal sciences, as has been already indicated, deal with objects which, in their formal character, render the existence of real objects possible, but which are also capable of independent perception and of ideal construction, and, as such, constitute the subject matter of a distinct group of sciences. The philosophical sciences, in so far as their content goes, do not form a class apart from either the formal or the real sciences. Both the former and the latter have for their aim the understanding of the same phenomenal world. The essential difference between the two is in the *extent* of the subject-matter with which they respectively deal. Each of the special sciences is limited to a particular sphere which it seeks to understand as perfectly as possible. Philosophy, on the other hand, seeks to show how these spheres, though distinct, are not separate but have an underlying unity of organization. This it does by means of an analysis and criticism of the fundamental conceptions which science and 'common sense' employ, and by a reduction of these conceptions to a single ground of unity.

In addition to this threefold division of the sciences, on a quite different principle from that of Spencer, Wundt also differs from the same philosopher in the position to which he assigns the mental sciences. These sciences in Wundt's scheme are placed upon a footing of complete equality with the sciences of nature. A new and important distinction is also introduced which is common to both these groups of sciences, although with a different application in the two cases. This is the distinction between processes and objects. According to this position, all phenomena may be regarded either from a dynamic or from a static point of view. The former aspect regards the world as changing; the latter as fixed and stable, and open to formal description and classification. Instances of the former division are the dynamics of masses, the dynamics of molecules, and the physics of light, heat, and electricity; of the latter are the sciences of astronomy, botany and zoölogy. The union of these two points of view is found in those sciences that treat of the processes of nature *in* the objects of nature, such as the physics and chemistry of the concrete bodies of nature, both organic and inorganic. In the case of the mental sciences, the distinction assumes the form of mental processes *vs.* mental creations. The typical science of mental processes is psychology. The sciences of mental creations are such as economics, the doctrine of right, and systematic theology. Mental phenomena, again, are to be distinguished from material phenomena as the processes of immediate, from those of mediate experience. The former treat of mental processes as they take place in the mind of the individual; the latter can form the data of any of the sciences when abstraction is made from the operation of the individual's consciousness. But if the difference between the spheres of mind and of nature is that between immediate and mediate experience, it is evident that there will be a corresponding difference in the forms of mental activity concerned in the determination of the facts of the respective sciences. Immediate experience is discovered primarily by introspection; while mediate experience requires to be ascertained by the employment of complex induction methods. Thus, this division is both a real division based on the nature of the subject matter, and a logical division based on the nature of the activity of mind employed in the ascertainment of scientific facts and laws.

This classification, which Wundt has worked out in detail, is undoubtedly in many respects a great improvement on that of Mr. Spencer. In his scheme, Wundt has at last brought the mental sciences to their true position and rescued them from their subordination to the physical and biological sciences. The philosophical disciplines are also recognized at their proper value and given an independent place as products of mental activity coördinate with the real and mathematical sciences.

In other respects, however, Wundt's classification appears to be open to unfavorable criticism. In his system, the distinction is not clearly made, or consistently carried through, between the subject-matter of the sciences and the forms of mental activity concerned in their elaboration. The mathematical sciences are distinguished from the sciences of nature and of mind as the formal from the real, but such a distinction does not serve to show wherein the mental processes in the construction of the two groups of sciences differ from each other. The philosophical sciences are given a position by themselves, but the logical methods that are peculiar to these subjects of inquiry are by no means sufficiently indicated. The division of the real sciences, again, into those concerned with mind, and those concerned with nature is not an essentially logical division. Nor is there a sufficient difference between these two fields of reality to warrant our regarding the psychological sciences as sciences of immediate, and the physical sciences as those of mediate experience. In the case of both classes of sciences, the immediateness or mediateness of any given process depends upon the manner in which this process is viewed, rather than upon the field of reality in which it occurs. The observation of a plant, for instance, is just as immediate as is the introspection of our state of mind which is concerned with such observation. So also, the full explanation of the psychical process of association is just as mediate or inferential as is the explanation of its co-relative physiological changes. Physical science as well as psychological science has to appeal constantly to immediate experience for a confirmation of its conclusions; and psychological as well as physical facts require to be explained causally, that is by reference to antecedent phenomena.

The further distinction that Wundt makes both within the material and mental sciences, that, namely, between processes and objects, has a real, though not apparent, logical foundation. This logical ground is exhibited in the fact that the former sciences do, and the latter sciences do not, call for explanation by means of preceding processes. A process necessarily has an antecedent stage which may be qualitatively or even generically different from its present stage, and this antecedent stage requires explanation if the process as a whole is to be exhibited. It is evident, however, that the processes that occur in nature do not take place accidentally or capriciously. There is a uniformity of natural occurrences that holds throughout all space and time. Given like conditions with regard to the happening of a particular event, and we may be sure that a like effect in every case will follow. Thus causal explanation is concerned, not merely with tracing the particular antecedent of a particular event, but with discovering its law or invariable mode of action. But although there is this uniformity existing in nature, there is also a great complexity in the causes and conditions of any particular occurrence. No event in nature is so simple as not to have more than one cause coöperating to produce it. It is, then, the task of scientific investigation to discover what are the causes concerned in the production of a given phenomenon, what antecedent events are irrelevant and also the precise manner and degree in which a given cause is active in bringing about the effect. There is also the problem—and in practical life this is the more important of the two—to determine what are the elements involved in a complex *antecedent* event, and what will be the probable *effect* of each of these elements. It is to resolve such great complexity that the inductive methods of experiment, hypothesis, agreement and difference, are brought into operation. Where objects as such are to be scientifically treated, none of the aforesaid methods are employed, but rather the methods of accurate observation and analysis, of comparison and of systematic classification. Here description rather than explanation is the aim of the scientist, although such description may require careful discrimination from related phenomena, as well as subsumption under appropriate species or genera. This description, when accurately given, holds good once for all, and demands no reference to phenomena out of which the given object has arisen or evolved. Thus, although Wundt has not made the fact explicit, there is a clearly marked logical distinction implied in his division of the real world into processes and objects.

In constructing a plan of classification upon ultimate principles, it would seem that two distinct factors must be given equal consideration. In the first place, such a classification should be based upon the nature of the mental activity concerned in the elaboration of the different sciences. The nature of this activity is best expressed, not by the principle of abstractness and concreteness, for that constitutes too general a principle of division, but by the particular character of the methods which the mind employs in dealing with the material furnished it by the different spheres into which reality is divided. On the other hand a classification based upon method is purely logical in its nature, because there is no reference to the character of the reality that the method undertakes to interpret. The same method may be applicable to widely different spheres of the real world. At the same time, the simplicity or complexity of the method constitutes an adequate criterion of the nature of the mental activity which is brought into exercise. Nevertheless, a division of the sciences based upon method needs to be supplemented by a division based upon the nature of the subject-matter upon which it is employed. The mind does not work *in vacuo*, but the possibility of its operation is conditioned by the experiential material which is presented to it. In every case the nature of the reality, with which consciousness deals, determines the particular direction of its methodical operation. While objects by themselves do not constitute an adequate principle of classification (for the same object, when regarded from different points of view, may furnish the subject matter of many different sciences), yet the nature of these objects must certainly be taken into account when constructing a classificatory scheme upon an adequate foundation. Otherwise, the plan proposed would be empty and formal, and would have no direct reference to the real world. Just as knowledge is constituted by interaction

METHODS.	OBJECTS.				
	CONCEPTUAL.		REAL.		
	Philosoph.	Mathematical.	Inorganic.	Organic.	Psychical.
Reflection.	Metaphysics. Theory of Knowledge. Logic. Ethics. Æsthetics. Theology.				
Deduction.		Geometry (Analytic and Synthetic). Arithmetic. Algebra.			
Deduction and Induction. (Theory, Hypothesis, Experiment, Agreement and Difference.)			Physics (General and Special). Chemistry (General and Special). Theory of the Ether. Astronomy (Mathematical). Geology (Dynamical).	Biology (General and Special). Physiology.	Psychology. Economics. Sociology. Pol. Science. History (Explanatory).
Observation, Comparison and Classifica'n.			Astronomy (Descriptive). Mineralogy. Geology (Structural and Historical). Geography.	Morphology. Anatomy. Botany. (Structural.) Zoölogy. (Structural.)	Anthropology. Ethnology. Philology. History (Descriptive).

between mental and physical processes, and differences in either of these factors will give differences in the total product, so a true scheme of classification needs to take account both of the acting mind, and the material upon which it operates. In other words, a true scheme of classification should be explicitly two-dimensional, having reference both to the logical nature of the mental activity involved, and to the distinctive character of the different spheres of reality, the sciences which it attempts methodically to arrange.

In the preceding table of illustrative sciences, both of these ultimate principles have been given equal prominence, and each of the leading sciences is classified from the two fundamental points of view of subject matter and logical method. The former point of view, or that of objects, is again regarded from the standpoint of real and conceptual objects. The distinction between these two subdivisions is, on the one hand, that of things existing in space and time, and therefore perceptible, or regarded after the analogy of perception, and, on the other, mental constructions considered in independence of the concrete subject-matter from which they are abstracted. This distinction, however, is not an absolute one, since the real sciences use laws and principles to interpret the concrete phenomena with which they deal and, again, the ideal constructions of geometry are capable of perceptual representation. Real objects are sub-divided into the distinct, though by no means separable, classes of the inorganic, the organic, and the psychical. The division of conceptual objects into philosophical and mathematical objects is made on the basis of logical universality and non-universality. The conceptions of philosophy are those that refer to the universal and ultimate nature of thought and reality, while those of mathematics have reference merely to the quantitative aspect under which reality is to be regarded. Space, for instance, when considered philosophically, has to be brought into connection with the wider realm of the knowable, especially with the overlapping activity of the mind. When, however, it is regarded mathematically, its province and its fundamental conceptions are rigorously defined, and definite results are obtained by confining scientific enquiry within precisely determined limits.

The division that has been given of logical methods is grounded upon the nature of the mental activity employed in interpreting the real world. In reflection, the mind adopts the regressive rather than the progressive attitude. It starts from a given fact or principle, and by analytical investigation seeks to determine the presuppositions upon which it is based. It thus advances, or rather recedes, from the particular to the general, from the given to its underlying assumptions. This is the method *par excellence* of philosophy. Its aim being to give an ultimate explanation of the real world, it starts from the assumption of ordinary knowledge and science, and by an analytical treatment of these data it endeavors to reach the 'first principles' upon which they are based. It takes nothing for granted, except, indeed, the rationality of thought and the knowability of things, but seeks to place all unanalyzed assumptions in the crucible of an all-embracing criticism. The method of deduction, on the other hand, is to advance from certain laws or principles to laws or facts that are of equal or less generality in their scope. This progress it accomplishes by combining different judgments in such a way as to give a valid conclusion. Such a combination does not take place in a mechanical fashion, but is accomplished syllogistically by passing from premise to conclusion by means of the continued identity of the middle term. The most perfect instance of deduction is found in mathematical reasoning. Here every stage of the inferential process is established with quantitative precision, a fact which enables the conclusion to be stated with a like degree of exactness. As the relation between deduction and induction is a very close one, these methods have been placed together in the scheme of classification that has been presented. The aim of all the causal sciences is to reach the position of being able to deduce particular facts from pre-established laws with unerring certainty. Thus, the more developed such a science becomes, the greater becomes the range and accuracy of its previsions. But in order to reach such a position, it is forced to pass through the preliminary stages of imperfect inductions which it tests by such methods as those of experiment, hypothesis, and agreement and difference. These inductions, in turn, cannot be confirmed solely by direct reference to concrete phenomena, but involve deductive inferences from laws already established. Thus, in the imperfectly developed condition of the real sciences, that exists at the present time, induction and deduction are mutually dependent. Even were these sciences placed upon a completely deductive basis, they should still be *taught* by passing the student through logical processes similar to those experienced by the sciences in question in the course of their formation. The last division we have made of logical methods, that, namely, into the methods of observation, comparison, and classification, implies, as has been indicated above, a static and descriptive way of viewing reality. Even where the objects of reference are processes, as happens in the case of history, these processes are treated simply in themselves and not as open to explanation by reference to antecedent processes. The three methods of this group have been placed together for the reason that they are inseparably involved in the construction of the descriptive sciences. Observation alone cannot lead to the construction of a science. There must be some principle, however superficial, which connects the facts observed, before this group of facts can be entitled to the rank of science. The most superficial of these principles are those of space and time, which serve as the bases, respectively, of geography and history, when these sciences are taken in their simplest and crudest possible acceptation. The mere spatial and chronological arrangement of parts, however, must be supplemented by comparison, by classification, or by causal explanation, if the resulting product is to take the name of a science. Thus anatomy is a science, not so much from the fact that it observes and arranges spatially the parts of the animal organism, as from the fact that it namest hose parts, and compares them with one another and with related organisms, with the purpose of discovering their essential points of identity as well as their minor points of difference.

The grouping of the sciences, that is here presented on the basis of the logical methods employed in their formation, must not be taken as by any means an absolute one. It may be truly said that no method is the exclusive property of any single group of sciences, that, in fact, every method is more or less directly involved in the construction of every science. All that our classification according to method designs to effect is to indicate the dominant or essential logical process employed in the elaboration of a given group of sciences. That other methods are necessarily involved in such elaboration does not detract from the validity of the classification. Thus the method of reflection occupies an important place in the construction of the psychical sciences, especially in the formulation of their definitions, but it is not the dominant or characteristic method which these sciences employ. Observation is a necessary preliminary process to the formation of physical or chemical inductions, but the main purpose of such inductions is to establish laws from which facts may be deduced without the intervention of immediate experience. Every system of classification is forced to recognize the fact, that, corresponding to the interdependence of the parts of its subject-matter, is the relativity of its classification and that, consequently, every one of its divisions is more or less applicable to every one of the parts of the reality with which it has to deal.

In the accompanying classificatory table no attempt has been made to give a complete list of the sciences which have been grouped under the different sub-divisions. All that has been designed to attain is to exhibit graphically the ultimate principles upon which a true classification should be based, and to place in their appropriate class the most important of the sciences. Nor, in the brief explanation of the grouping that has been given, is any attempt made at an exhaustive treatment of the subject. Lack of space, as well as lack of knowledge of the details of the special sciences, precludes the writer from completely carrying out this programme. What has been attempted is to select those sciences that are most typical, and seem most to call for explanation, and briefly to describe their character, and to give the reasons for the places to which they have been assigned.

Of the philosophical sciences, metaphysics seeks to determine the ultimate constitution of the world. It asks such questions as, Is reality, in the last resort, one or many? Is it real or ideal? Is it spiritual or material? In order to obtain an answer to such questions it requires to examine reflectively the conceptions both of science and of ordinary thought, since it is through the judgments of science and of 'common sense' that an acquaintance with the nature of the real world is rendered possible. Thus it seems that metaphysics presupposes a theory of knowledge. Such a theory implies an investigation of the relation between the mind and its object, as well as an enquiry into the nature of the different elements of knowledge and the connection that exists between them. Logic, in distinction from epistemology, deals with the distinctively *rational* part of knowledge, or knowledge as it is constituted by judgment and inference. Formal logic is concerned simply with the various linguistic forms that judgment and inference assume, without regard to the content or meaning which these forms express. Speculative logic, on the other hand, treats of the act of thought in its necessary connection with an object, and evaluates its judging and reasoning processes on the basis of the reality which these processes interpret. Ethics and æsthetics may be regarded either as real or as conceptual sciences. From the former standpoint, ethics asks the question, What do men actually aim at? What do they in common desire? From the philosophical point of view, on the other hand, it deals with the ultimate nature of such conceptions as the pleasant—the unpleasant, the right—the wrong, the good—the bad. In the same way, æsthetics, as a real science, studies standard works of art with the aim of discovering the principles that determine taste and enter into the construction of the beautiful; as a philosophical discipline, it enquires concerning the way in which, and the extent to which, these principles are constitutive of knowledge and reality.

The real sciences, which are formed through the employment of the combined method of deduction and induction, may be divided into those whose laws are, and those whose laws are not, capable of precise quantitative statement. To the former belong the inorganic and the organic, to the latter, the psychical, sciences. The reason for this fact is, that the processes and objects of the physical and biological sciences can be weighed and measured by exact quantitative units, whereas, psychological processes are irreducible to a numerical basis of measurement. Yet the psychical sciences are not on that account prevented from reaching a highly deductive position. Psychical qualities have duration and degrees of intensity, and the relation between stimulus and sensation is expressible in roughly exact quantitative terms. Psycho-physical generalizations, as well generalizations as to the relations between one psychical process and another, can be established, and from these laws facts can be deduced with an approximate degree of exactness. The leading inductive sciences, again, may be regarded either from a general or from a special point of view. Thus physics, from the former standpoint, investigates the laws of composition and resolution of forces, and the laws of the movements of masses and molecules. From the special point of view, it treats of the properties and laws of such phenomena as heat, light, sound, and electricity. General chemistry is concerned with the nature of the connection between physical and chemical processes, and with an elaboration of the atomic theory. Special chemistry treats of the analysis of material substances into their elements, and with the laws by which these elements are combined with one another. Biology may be regarded either from the point of view of the origin, reproduction, and evolution of life, or from that of the structure and function of cells and of protoplasm. Economics is deductive to the extent that it derives new truths from such pre-established laws as those of diminishing returns and of marginal utility. It is inductive to the extent that these laws are obtained through the observation of present economic facts and relations, or through historical analysis. In a like way, sociology is deductive and theoretical in so far as it deals, *a priori*, with the laws that are observed to obtain in such social relations as those of group affinities and antagonisms. It is inductive in so far as it infers from present or past social phenomena the laws that represent the order and progress of society. History is explanatory in so far as it investigates the causes and tendencies of events, and is enabled from the laws thus generalized to predict, with greater or less minuteness, the events to take place in the future. It is descriptive in so far as it deals with such events merely *as* events, and in the order of succession in which they actually occurred.

We close this sketch of some of the essential characteristics of the leading sciences by a single additional word of explanation. A separate place has not been assigned to the history of the different sciences, for the reason that the history of scientific ideas is so intimately bound up with the nature of these sciences themselves as to constitute practically the same subject of enquiry. A knowledge of the history of a given science from its inception to its present stage of development, presupposes an acquaintance with its facts, laws, and methods. A science and the history of its development are not so much separate disciplines as two distinguishable aspects of the same sphere of investigation.

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